THURSDAY, NOVEMBER 9, 1911.

TIDAL ACTION AND COSMOGONY.

The Tides and Kindred Phenomena in the Solar System. The substance of lectures delivered in 1897 at the Lowell Institute, Boston, Massachusetts, by Sir G. H. Darwin, K.C.B. Third edition. Pp. xxiv+437. (London: John Murray, 1911.) Price 7*s.* 6*d.* net.

THE first edition of this book appeared in 1898, and was reviewed in NATURE, vol. lix., p. 219. The work has since taken rank as a classic in its way, and has been translated into several languages. There is no need, therefore, to dwell at any length on its general character and purpose. It aims at giving, with as few technicalities as possible, a summary of the researches on tidal theory, and more especially on the theory of tidal evolution, which have been the principal occupation of the author's long scientific career. It would be misleading to describe it merely as a "popular" book, for it is a valuable guide even to experts who might otherwise be dismayed by the long and intricate calculations in which the original investigations necessarily abound. In this respect it may perhaps be compared with the celebrated "Exposition du Système du Monde" which Laplace added as a supplement to the detailed work of the "Mécanique Céleste." It is true that the subject-matter is in the present case more speculative, but the purpose is the same, and the execution not unworthy of the great exemplar.

In this third edition some additions and alterations have, however, been made which call for notice. These consist in part of supplementary notes to the earlier chapters, in which brief summaries are given of recent work bearing on the various topics. Thus at the end of the first chapter there is an interesting account of deep-sea tide gauges, with a tantalising indication of the valuable results which might be obtained if an extended and systematic use of such appliances were practicable. The appreciative account of Forel's early investigations of the "seiches" of the Lake of Geneva is appropriately supplemented by a reference to Chrystal's recent work on the Scottish lochs. The remarkable observations of Dr. Hecker on the lunar disturbance of gravity, which are the successful realisation of an interprise in which Sir G. Darwin himself led the way, are described with generous enthusiasm. In the absence of any authoritative account in English of these experiments, it is perhaps to be regretted that the description is not still more ample. Their value consists, of course, in the inferences which they justify as to the degree of rigidity of the earth. The other lines of evidence bearing on the same question, viz. those based on observations of the fortnightly tide, and on the free (Eulerian) nutation of the earth's axis, are also explained and discussed, the general conclusion being that the earth's surface yields, under the action of tidal or precessional force, about two-fifths as much as if it were absolutely devoid of rigidity. The more recent work of Love and Larmor, in which a greater degree of precision is given to the inferences which can be drawn from the respective lines of argument, was probably judged to be of too refined a character to admit of elementary treatment.

The views of the author as to the age of the earth, and the scale of geological time, have, as explained in this edition, undergone considerable modification. In 1898 the arguments of Lord Kelvin, which assigned a comparatively moderate age to the solid earth, were in the ascendant; but the rapid and startling succession of discoveries in radio-activity have undermined much of the reasoning based on such considerations as the output of energy from the sun and the secular cooling of the earth. Moreover, the researches of Strutt claim positively to demonstrate an enormous antiquity for certain rocks, far transcending the limits formerly accepted by physicists. On the other hand, an altogether independent estimate by Joly, based on a comparison of the amount of sodium in the ocean with the amount annually carried into it by rivers, would give to the existing ocean an age of about 100 million years at most, a figure which is on the scale of Kelvin's results. The discrepancy is at present unexplained, but we may note an interesting essay on the subject by Joly, in a recent number of the *Phil. Mag.* (September, 1911). Sir G. Darwin inclines, on a review of the whole evidence, to the belief that there is no assignable limit to the fund of time on which biologists may draw for the purpose of their evolutionary theories.

The last three chapters of the book are almost altogether new. The first of these is devoted to a general explanation of the theory of "figures of equilibrium" of rotating fluid, a classical problem with which the names of Maclaurin, Jacobi, Roche, Poincaré, and Darwin will always be associated. The theory of the stability of the various forms is of too technical a character to admit of really elementary treatment, but the summary will be welcome even to mathematicians, as a survey of a somewhat intricate subject. The succeeding chapter, one of the most fascinating in the book, gives a striking application of the theory to the phenomena of variable stars. The evolution of binary stars, a very attractive subject, is also considered, but the intricacy of such speculations is exemplified by the fact that a new source of instability, known as "gravitational instability," comes into play in the case of a gaseous mass. The concluding chapter treats of the nebular hypothesis of Laplace, and of the more important modifications of it which have been proposed by subsequent writers. In particular the "planetesimal" hypothesis of Chamberlin and Moulton, which was suggested by the observed prevalent spiral configuration of many nebulæ, is discussed at some length. Some speculations have an invincible attraction for the mind, but the critical reader will have an uneasy feeling that here at any rate he is making doubtful ventures into a mysterious region, far away from any secure dynamical base.

It would be wrong to end this notice without a word of admiration for the modesty and restraint which the author has shown in setting forth the results of speculations in the origin and development of which he has himself borne a predominant part.

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The results of theoretical reasoning are always stated with scrupulous care, and their limitations clearly expressed, and no attempt is made to press conclusions based on idealised premises further than the case will warrant. A striking instance of this is furnished by the way in which, after developing his theory of the evolution of the earth-moon system with justifiable enthusiasm and evident faith, he takes care frankly to point out that other agencies must probably be sought to account for the origin of the satellites of the exterior planets and of the planets themselves.

H. L.

RECENT ADVANCES IN THE GENETICS OF PLANTS.

Einführung in die experimentelle Vererbungslehre By Prof. E. Baur. Pp. vi + 293. (Berlin: Gebrüder Borntraeger, 1911.) Price 8.50 marks.

PROF. ERWIN BAUR is well known to students of genetics as a most successful investigator. The fifteen lectures included in the present volume were delivered as a course in Berlin, and they constitute an admirable text-book of the subject, which will do much to familiarise Continental biologists with the methods of Mendelian analysis and the deductions to which it has led. The coloured pictures are exceptionally good. No clearer or better illustrated account of the present state of knowledge of these matters could be desired.

Some years ago Prof. Baur began a series of researches into the nature of variegation in plants, without any special intention of investigating Mendelian phenomena, but, like so many others engaged on special problems, he soon found that a knowledge of heredity was indispensable to a proper understanding of his subject. The breeding experiments then instituted, though begun as a side-issue, have illuminated the whole field. His first success was obtained in a study of the golden-leaved Antirrhinum, which he proved to be a heterozygous form, possessing only one factor for greenness. Self-fertilised, it gives two yellows to one green, the missing term in the series being the homozygous albinos which perish on germination.

This led to a comprehensive examination of the inheritance of flower-colour in *A. majus,* a subject also studied by Miss Wheldale in this country. The series of types is very large, seeming at first sight almost continuous, and the analysis was exceptionally troublesome, but it is satisfactory to know that though working independently, both observers have arrived at practically the same conclusions as to the factorial composition of the several forms. In this book Antirrhinum is naturally taken as the typical example of the effects of combinations of long series of factors, and the reader who masters this example will have encountered most of the complications which ordinary Mendelian inheritance presents.

From this work on the varieties of a single species Baur has gone on to less familiar ground, and in this book he gives the first results of his experiments on the interrelation of forms which are quite distinct species in the systematic sense, especially *A. majus* and *A. molle*. The F_1 plants are fully fertile, and F_2 shows a long series of diverse types resulting from the recombination of segregating factors, but the analysis is still to be completed. One observation of extraordinary interest is announced, namely, that the self-sterility of *A. molle* is a recessive. This announcement must be regarded as preliminary, but if established, the discovery will constitute a striking advance. Self-sterility is one of the greatest paradoxes in nature. If it is true, as we are almost forced to believe, that a self-sterile plant can be fertilised by the pollen of *any* other individual but not by its own, then each individual is differentiated by virtue of its individuality, and there are as many classes as individuals. The notion once suggested by de Vries, which I also had formerly entertained, that there are in reality several *classes* of individuals and that probably fertilisation was inoperative only within each class, is negatived by such experiments as have been made by others and by myself (on a small scale in *Linaria vulgaris*). If self-fertility be a dominant, the main mystery is still unsolved, but we have a new fact of great consequence which may lead to a solution.

The most important chapters are those in which Baur describes his discoveries regarding the inheritance of the several forms of "Chimæra," the term Winkler has introduced to denote patchwork or mosaic individuals. In a variegated Pelargonium, for instance, the albino parts of the vegetative organs may be *sectorial* forming radiating patches of white, or *periclinal,* in which case the external layers of cells may be green and the internal white; or conversely the internal may be green and the external cells white. Baur has shown that the colour of the offspring, whether green or white, depends on the nature of the subepidermal layer of cells from which the parental germ-cells were derived. If in the periclinal chimæra the two peripheral layers of cells are green, the offspring (of self-fertilisation) are all green; if the peripheral layers are albino the offspring are all albino, and, of course, perish. If only the outer cell-layer is white the offspring are green. In either case the particoloured character does not reappear in the offspring. From the sectorial chimæras the inheritance is more complex, and much remains to be cleared up. This discovery of the significance of the subepidermal layer is one of very great importance, and we may anticipate that it will lead to remarkable extensions. It may not improbably lead to a reconsideration of the generally accepted doctrine that segregation takes place in gametogenesis.

Baur has applied these observations to the interpretation of the curious "graft-hybrids" between *Solanum nigrum* and the tomato, first made by Winkler. Some of these were obviously sectorial patchworks of the two species, but Baur suggested that of the others some were actual periclinal chimæras, in which a foundation of tomato was enclosed in one or in two cell-layers of *S. nigrum,* or conversely *S. nigrum* enclosed in an outer sheath of tomato tissue. This conclusion was at first strongly resisted by Winkler, but in a preliminary communication he has since announced the proof that it is correct, having himself by cytological investigation of the growing

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